REPORT NO. 2473
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(NASA Contract NAS8-5282) (NASA CR-55954)

Monthly Progress Report

DESIGN, DEVELOPMENT AND PROTOTYPE FABRICATION OF AN AREA HYDROGEN DETECTOR

(1 October 1963 ~~Through~~ 31 October 1963)

(H) OTS

OTS: PRICE

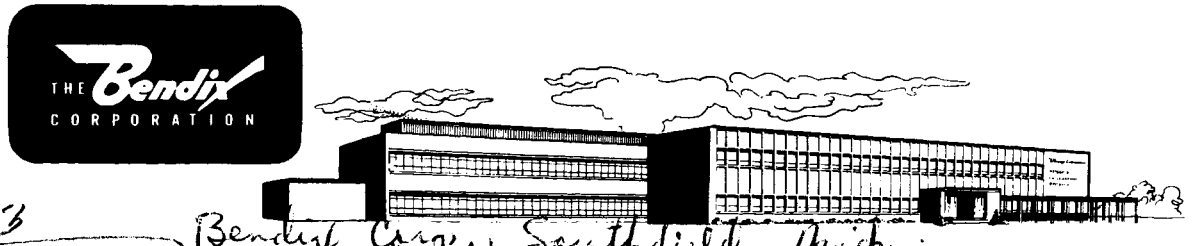
XEROX $ 1.60 ph

MICROFILM $ 0.80 mf

NASA CR-55954

P.A. Michaels 14 Nov. 1963

17p mfp



0401963 Bendix Corp., Southfield, Mich.

RESEARCH LABORATORIES DIVISION
SOUTHFIELD (Detroit) MICHIGAN

SOT-13322

Report No. 2473

Monthly Progress Report:

DESIGN, DEVELOPMENT AND PROTOTYPE FABRICATION OF AN AREA HYDROGEN DETECTOR (1 October 1963 Through 31 October 1963)

14 November 1963

Submitted to

George C. Marshall Space Flight Center
Huntsville, Alabama
(under Contract No. NAS 8-5282)

By

The Bendix Corporation
Research Laboratories Division
Southfield, Michigan

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SECTION 1

PROGRAM STATUS

The major effort for the month of October was directed toward the completion of the breadboard hydrogen detector. All electronic circuit boards for the control assembly were constructed and tested as individual circuits. The sensor element temperature control circuitry design was modified to prevent an unwanted oscillation. Additional design changes were made in the sensor assembly, fan-drive inverter, fan-motor control, and power supply circuits to decrease the total power consumption and simplify the system construction. These changes are described in detail in Section 3, and have all been incorporated in the construction of individual subassembly components. The remaining task is that of assembling the components into a packaged system and testing the system. This work will be accomplished during the first part of November.

SECTION 2

BREADBOARD DESIGN

2.1 GENERAL

The breadboard hydrogen detector as proposed in the Bendix Research Laboratories Report No. 2399, entitled "Area Hydrogen Detector Breadboard Design," and with the modifications described in the "Quarterly Progress Report, 1 July 1963 through 30 September 1963," Report No. 2442, was constructed during October 1963. During the construction phase and checkout of the detector set, a number of problems appeared which required a redesign of some portions of the system. Those changes and additions are described in the following subsections.

2.2 SENSOR ASSEMBLY

Three modifications have been made to the epoxy-glass support plate, referenced in drawing B215348. A small stop has been added in the support channel to assist in the end alignment of the heater, heat diffusor assembly, and the sensor element. The second modification is the addition of a teflon cushion at the bottom of the support channel. The cushion, drawing No. B-2153967, consists of a thin teflon film backed with a thermosetting silicon adhesive; the cushion is approximately 0.0035 inch thick. It serves to reduce the mechanical strain on the heater element during rapid temperature cycling. The third modification is the addition of two standoff terminals outside of the support channel to serve as tie-points for the motor-thermistor temperature sensor. Engineering drawings D-2153341-X3, B-2153348-X2, and B-2153349-X3 enclosed in this report replace the similarly numbered earlier drawings.

The previous air blower drawings did not show the location and mounting details of the motor-thermistor temperature sensor. These details are now shown in the accompanying engineering drawing D-2153341-X3.

2.3 FAN-MOTOR CONTROL

The circuit for the fan-motor control, as published in the breadboard design report, had an error in that the +28 volt connection to the

left hand transistor was inadvertantly omitted. A corrected circuit is shown as Figure 2-1. A number of other minor changes have also been included.

Type 2N930 transistors have been substituted for the 2N929 units originally specified. Both types will work satisfactorily; however, for the sake of convenience and uniformity, 2N930 transistors are being used wherever either type 2N929 or type 2N338 transistors were previously specified.

The small 0.01 microfarad non-polar filter capacitance, used to prevent false triggering of the relay due to noise picked-up by the thermistor leads, was not readily available. Hence, a tantalum capacitor has been placed in parallel with the thermistor (but on the motor control card). The performance of the two circuits is equivalent.

The original fan-motor control circuit consumed approximately 1.1 watts of standby power. This was considered excessive; consequently, a current limiting resistor was added in the +28 volt line, to reduce the required standby power by half. In order to equalize the heat loading in the control assembly package, the current limiting resistor was placed on the power supply card.

2.4 FAN-DRIVE INVERTER

Four germanium transistors were employed in the fan-drive inverter circuit, described in the Design Report No. 2399. This circuit, which performed satisfactorily at ambient temperatures to above 85°C, was rather bulky and could not be conveniently fitted into the control assembly package. The circuit was redesigned, as a two-silicon-transistor self-synchronized square wave oscillator (Figure 2-2). Particular emphasis was placed on the design of the feedback loop to ensure satisfactory operation with either a heavy motor load or no motor load (which will occur if the motor frame overheats). The over-all power conversion efficiency is about 85 percent.

2.5 SENSOR TEMPERATURE CONTROLLER

During tests of the completed sensor temperature controller, it was ascertained that the system oscillated at a frequency of approximately one cycle per second. The temperature control of the sensor element seemed adequate, but the low frequency on-off characteristic of the supply current caused considerable interference to the rest of the system.

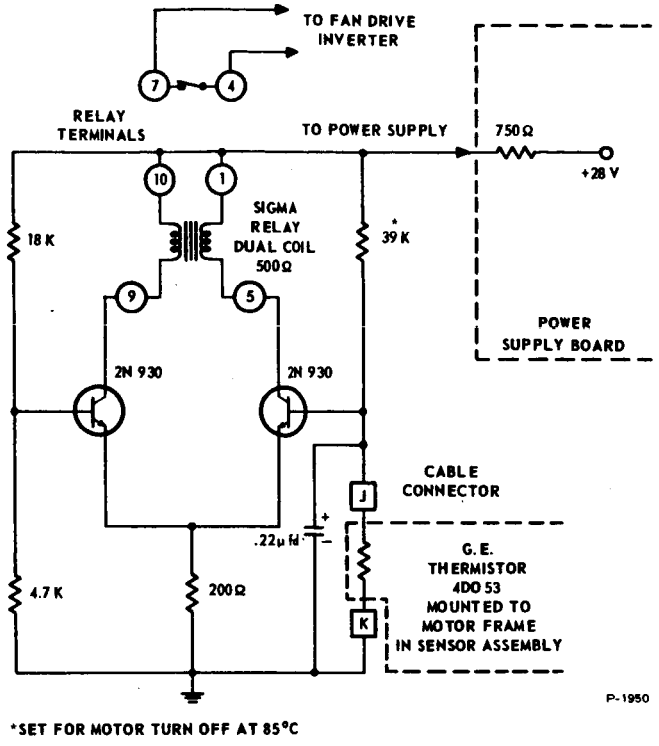


Figure 2-1 - Fan-Motor Control

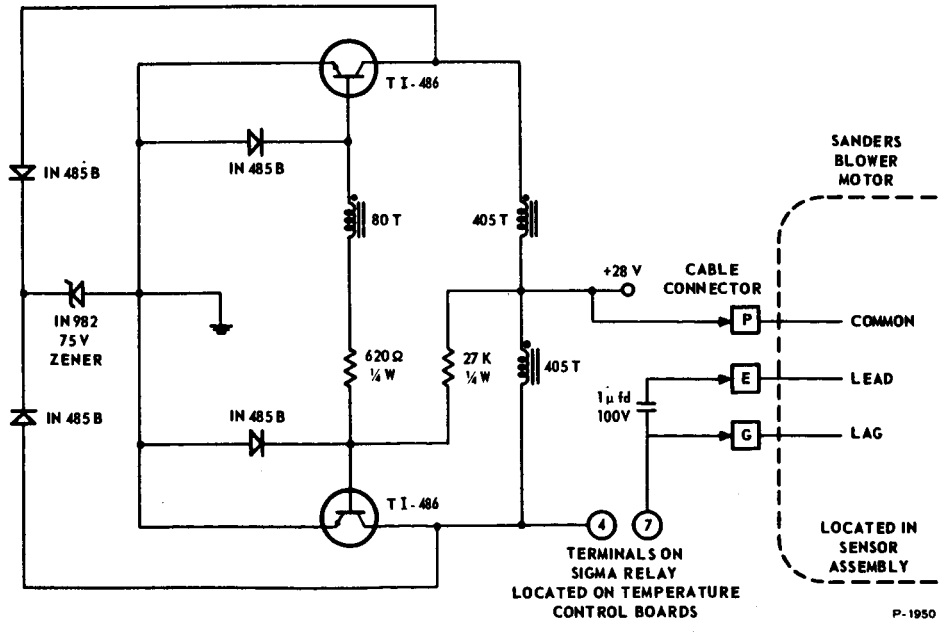


Figure 2-2 - Fan-Drive Inverter

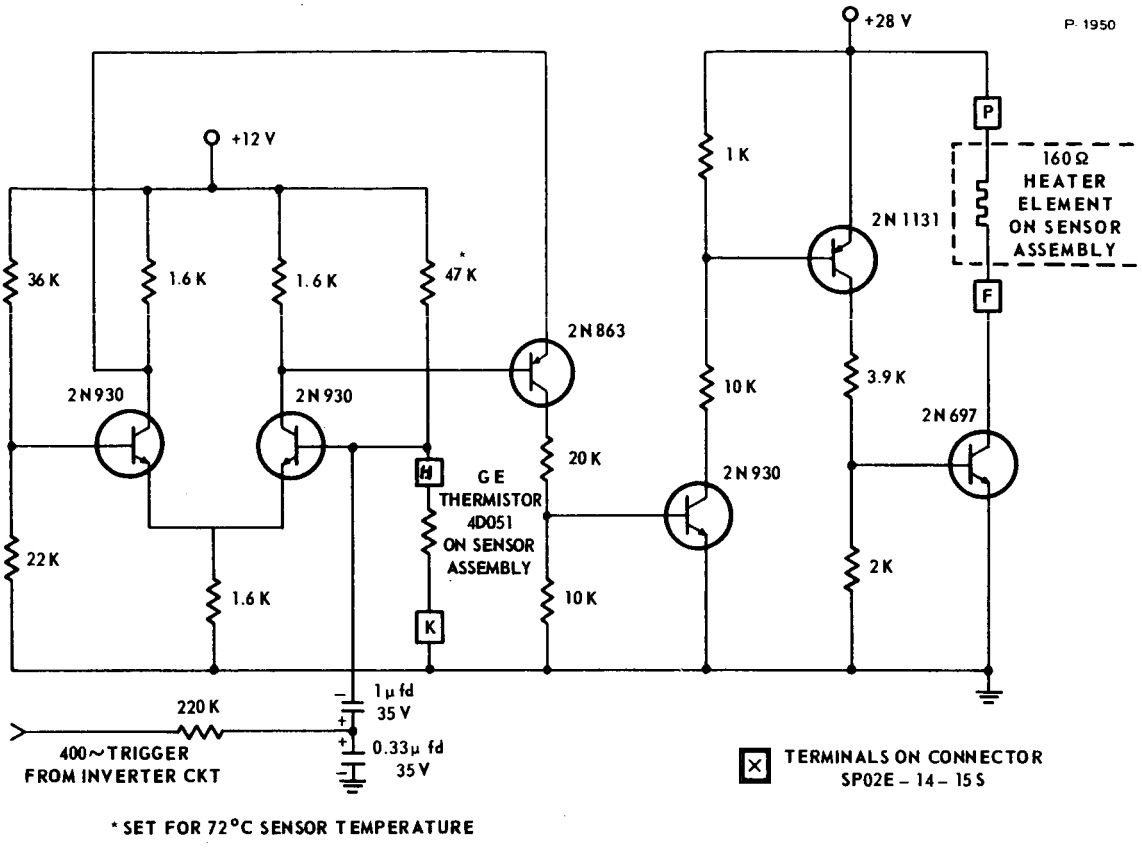


Figure 2-3 - Sensor Temperature Controller

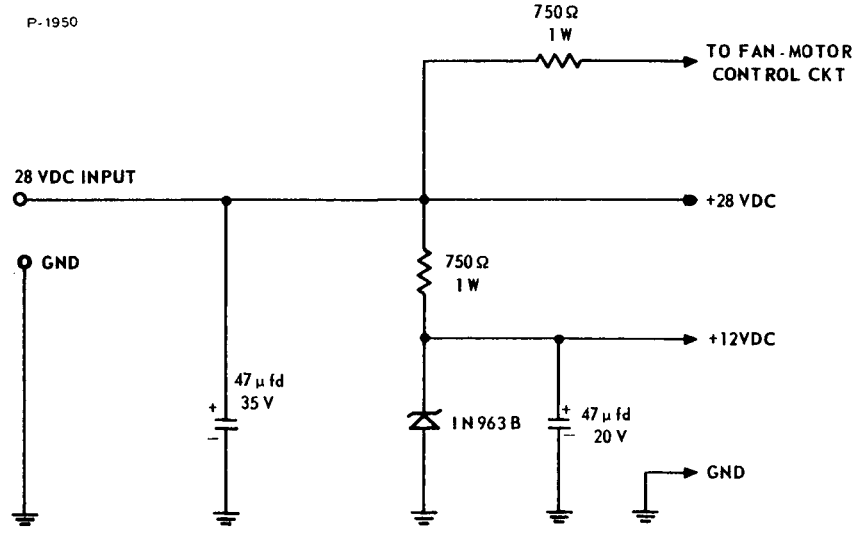


Figure 2-4 - Power Supply

By modifying the circuitry so that the modulating triangular wave drive signal is fed to the input of the differential amplifier, it becomes quite simple to adjust the modulation span (in °C) to achieve a stable loop gain. The modified circuit is shown in Figure 2-3. With the circuit values shown, a sensor element temperature of approximately 72°C is established. Calibration curves for temperature versus the R_C value covering the temperature range between 50°C and 125°C will be supplied with the breadboard detector.

2.6 POWER SUPPLY

The improved design of all of the sensitive circuits has eliminated the need for the elaborate LC interstage filters. All circuit power requirements seem to be adequately met by the simple power supply system shown in Figure 2-4.

2.7 CONNECTOR PIN ASSIGNMENTS

Pin assignments have been made for both the power input connector and the sensor assembly connector. The pin assignments are given in Table 2-1. Different shell sizes and pin numbers have been employed to eliminate any possibility of mismating the two connectors.

Table 2-1

POWER CONNECTOR - SPO2E-12-10P

Pin	Function
A	Ground
B	+28 Volts
C	High Calibrate
D	Low Calibrate
E	Spare
F	Spare
G	+ Telemetry Output
H	- Telemetry Output
J	Calibrate Return
K	Shield Ground

Table 2-1 - (Cont'd)

SENSOR ASSEMBLY CONNECTOR - SPO2E-14-15S

Pin	Function
A	Palladium Sensor
B	Shield Ground
C	Spare
D	Shield Ground
E	Fan Motor (Lead)
F	Heater
G	Fan Motor (Lag)
H	Thermistor (Sensor Temperature Control)
J	Thermistor (Fan-Motor Control)
K	Thermistor Ground
L	Palladium Reference
M	Palladium Common
N	Spare
P	Fan Motor and Heater Common
R	Shield Ground

SECTION 3

BREADBOARD CONSTRUCTION

The sensor assembly construction, with the changes discussed in the previous section, has been completed. A cable clamp, not discussed in the previous section, will be used to prevent sensor assembly cable movements from damaging the circuit board terminals. This clamp is now being designed and will be incorporated into the breadboard detector package before delivery.

All subassemblies, with the modifications included, have been individually tested and found to be satisfactory. They are now being assembled as an operating, packaged system. It is anticipated that system tests will be initiated about mid-November and that delivery will be made about two weeks later.

SECTION 4

MAN HOURS EXPENDED

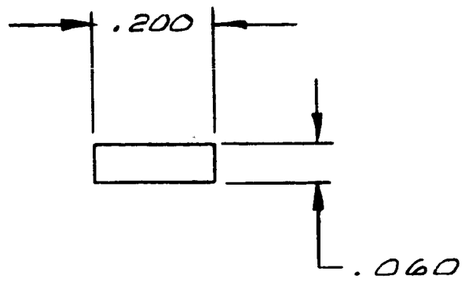
The following labor hours have been expended during the month of October, 1963.

Engineer	43.0
Technician	252.0
Design	10.0
Shop	19.9
Miscellaneous	20.4

K&E 195L 1-62•

2153967 | X1

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVAL



QTY REQD	PART NO.	DESCRIPTION	MATERIAL DESCRIPTION & SPECIFICATION	CODE IDENT	ITEM NO.
			.020 THK. GLASS EPOXY		

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED

- INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-70327
- DIMENSIONS ARE IN INCHES
- DIMENSIONS TO BE MET AFTER PLATING
- MACHINED SURFACES TO BE SQUARE & PARALLEL TO DATUM **A** WITHIN .005 PER IN.
- MACHINED DIAMETERS TO BE CONCENTRIC WITH DATUM **A** WITHIN .005 T I R

DRAWN	AL. CAIN	11-13-63
CHECKED		
GROUP LEADER		
ELEC ENGR		
MECH ENGR		
PROJ ENGR		

THE Bendix CORPORATION
RESEARCH LABORATORIES DIVISION
SOUTHFIELD, MICHIGAN

TITLE

STRIP, SPACER

BE153348	
NEXT ASSY	FINAL ASSY
APPLICATION	
CONTRACT NUMBER	

DECIMAL TOLERANCES
.X ± .040
.XX ± .020
.XXX ± .010
ANGLES ± 0°-30′ EXCEPT SPECIFIED CHAMFER ± 10°
SURFACE FINISH MICROINCHES R H R _____

APPROVED

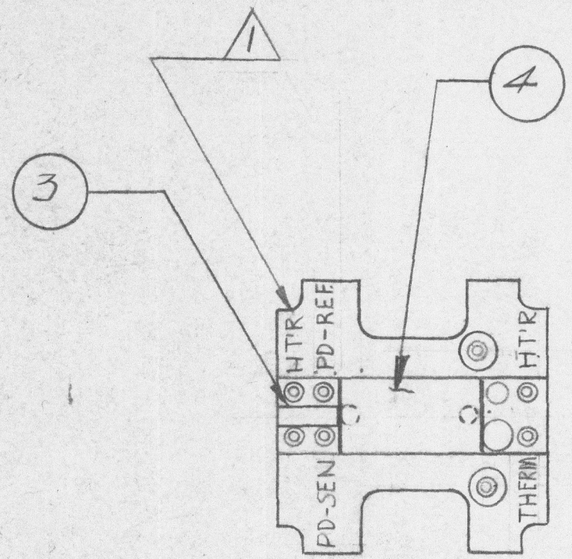
APPROVED

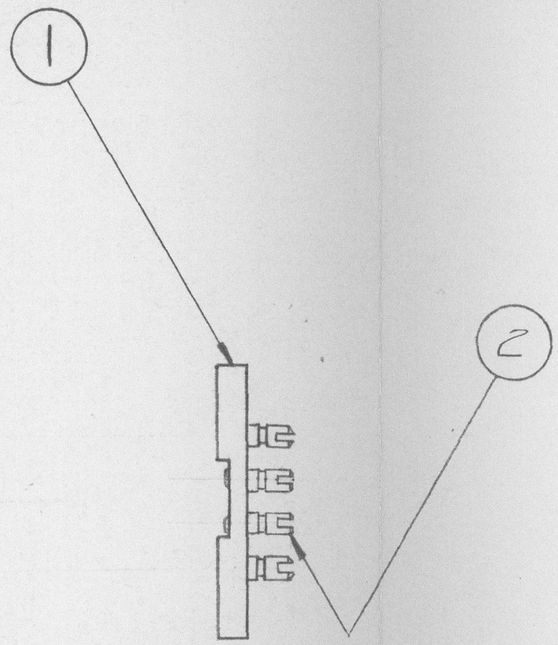
CODE IDENT NO.	SIZE		
11272	B	2153967	X,
SCALE 2/1	WT		SHEET

K&E 195L 1-62•

2153348 X2

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVAL





SOURCE:
THE CONN. HARD RUBBER CO.

⚠1 LETTER WITH BLACK INK OR LUSTERLESS BLACK ENAMEL (AIR DRY)

NOTES:

QTY REQD	PART NO.	DESCRIPTION	MATERIAL DESCRIPTION & SPECIFICATION	CODE IDENT	ITEM NO.
1	STOCK	TAPE TEFLON	TEMP-R-TAPE-C .003 THK		4
1	B 2153967	STRIP SPACER			3
8	STOCK	MINIATURE SPLIT TERMINAL	CTC NO. 1089-3		2
1	B 2153349	SUPPORT PLATE			1

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED

- INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-70327
- DIMENSIONS ARE IN INCHES
- DIMENSIONS TO BE MET AFTER PLATING
- MACHINED SURFACES TO BE SQUARE & PARALLEL TO DATUM **A** WITHIN .005 PER IN.
- MACHINED DIAMETERS TO BE CONCENTRIC WITH DATUM **A** WITHIN .005 T I R

TOLERANCES

DECIMAL
.X ± .040
.XX ± .020
.XXX ± .010

ANGLES
± 0°-30′ EXCEPT
SPECIFIED CHAMFER ± 10°

SURFACE FINISH MICROINCHES R H R_____

	D2153341
NEXT ASSY	FINAL ASSY
APPLICATION	
CONTRACT NUMBER 2314-001	

DRAWN	AL. CAIN	8-22-63
CHECKED		
GROUP LEADER		
ELEC ENGR		
MECH ENGR		
PROJ ENGR	R.A. Machado	8-26-63

W.D. Walker 8/24/3
APPROVED

APPROVED

THE Bendix CORPORATION
RESEARCH LABORATORIES DIVISION
SOUTHFIELD, MICHIGAN

TITLE

PLATE, SUPPORT ASSEMBLY
(AREA H_2 SENSOR)

CODE IDENT NO.	SIZE		
11272	B	2153348	X2
SCALE 2/1	WT		SHEET

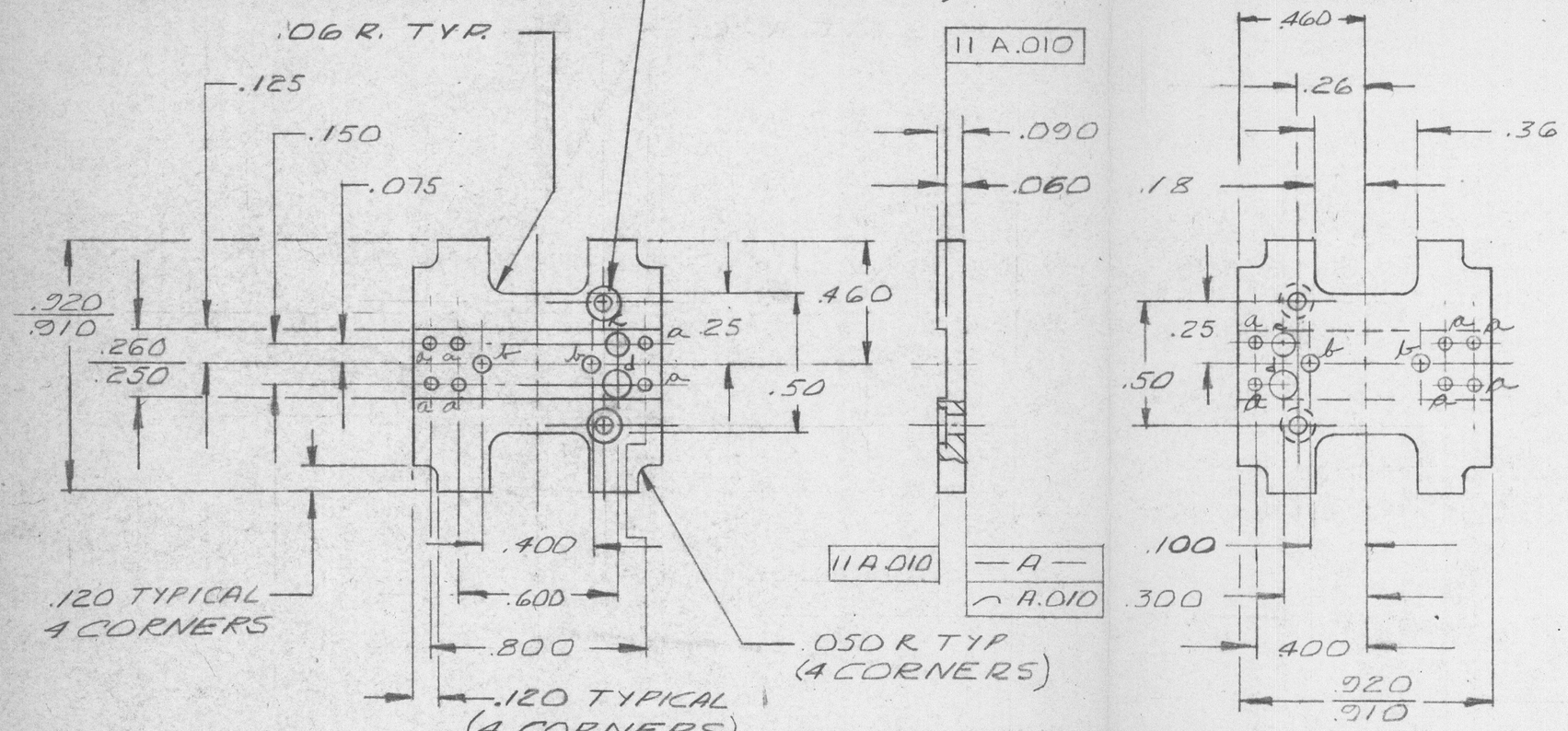
X2

2153348

K&E 195L 1-62•

2153349 | X3

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPROVAL



HOLE LEGEND		
HOLE SYMBOL	HOLE SIZE (DIA)	HOLE QUANTITY
a	.047/.051	6
b	.062	2
c	.086	1
d	.100	1

QTY REQD	PART NO.	DESCRIPTION	MATERIAL DESCRIPTION & SPECIFICATION	CODE IDENT	ITEM NO.
1			GLASS, EPOXY		

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED

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- MACHINED DIAMETERS TO BE CONCENTRIC WITH DATUM **A** WITHIN .005 T I R

DRAWN	AL. CAIN	8-21-63
CHECKED		
GROUP LEADER		
ELEC ENGR		
MECH ENGR		
PROJ ENGR	P.A. Mirabel	8-26-63

THE Bendix CORPORATION
RESEARCH LABORATORIES DIVISION
SOUTHFIELD, MICHIGAN

TITLE

PLATE, SUPPORT
(AREA H_2 SENSOR)

BZ153348	DZ153341
NEXT ASSY —	FINAL ASSY
APPLICATION	
CONTRACT NUMBER	

TOLERANCES

DECIMAL
.X ± .040
.XX ± .020
.XXX ± .010

ANGLES
± 0°-30' EXCEPT
SPECIFIED CHAMFER ± 10°

SURFACE FINISH MICROINCHES R H R

W D Wilcox 8/26/63
APPROVED

APPROVED

CODE IDENT NO.	SIZE		
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SCALE 2/1	WT		SHEET

2153349 X3

REVISIONS				
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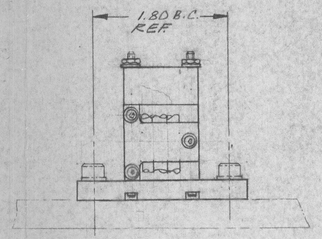

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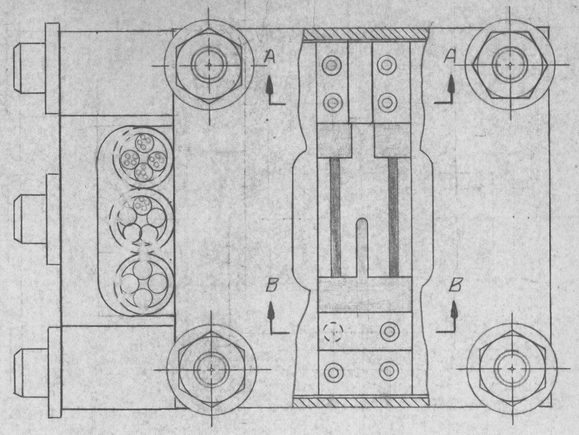

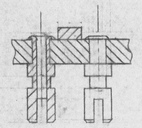

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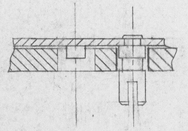

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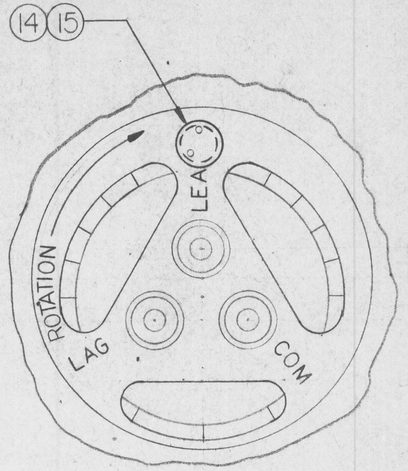

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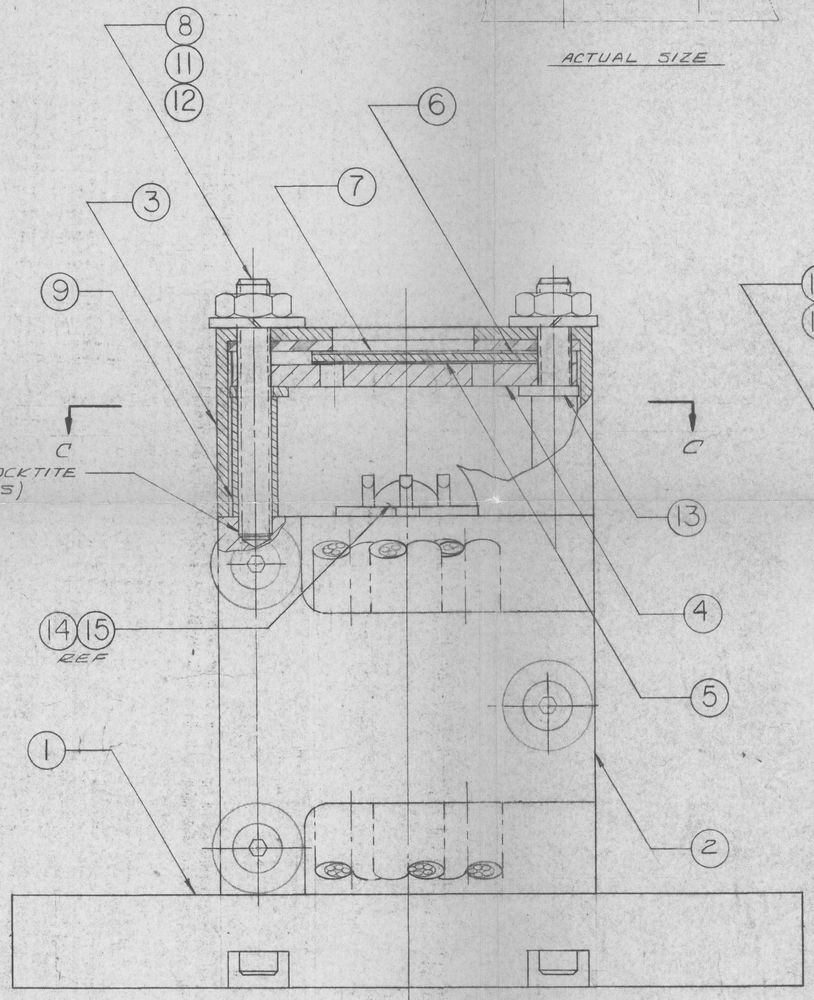

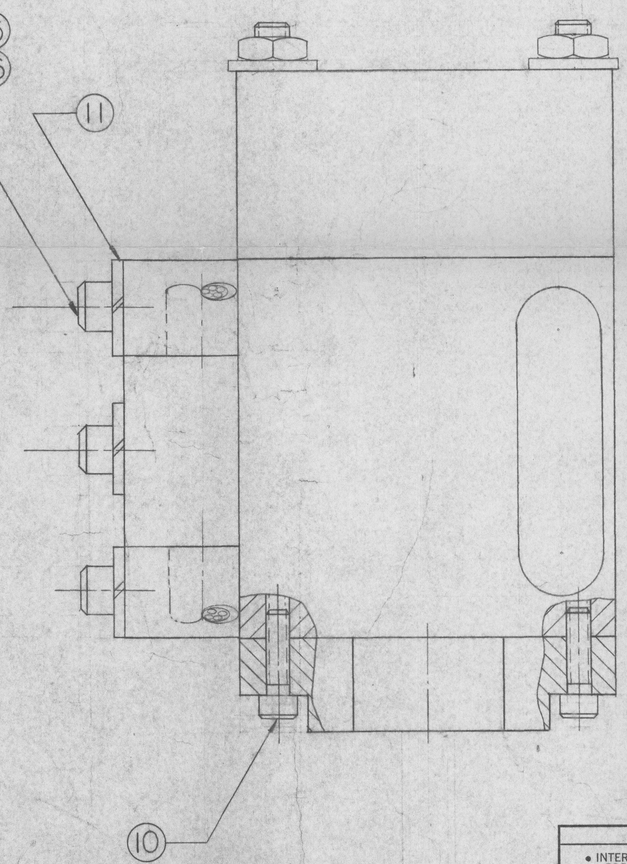

QTY REQD	DWG SIZE	PART NO.	DESCRIPTION	MATERIAL DESCRIPTION & SPECIFICATION	CODE IDENT	ITEM NO.
3		STOCK	SOC.HD CAP SCREW	2-56UNC-2A LONG STL.		17
1	B		CLAMP CABLE			16
AS REQD		STOCK	CEMENT EPOXY	TECH FORM LABS NO. EA3000A		15
1		STOCK	THERMISTOR	GENERAL ELECTRIC NO. 400 53		14
4	B	2153449	WASHER, SUPPORT PLATE			13
4		STOCK	NUT, JAM	#2-56 UNC-2B STL.		12
7		STOCK	WASHER, SPLIT, LOCK	#2 STL.		11
4		STOCK	SOCKET HEAD CAP SCREW	#2-56 UNC-2A .25 LONG STL		10
4	B	2153357-1	STANDOFF			9
4	B	2153354	STUD, SUPPORT			8
1	B	2153353	SENSOR ELEMENT			7
1	B	2153351	HEAT DIFFUSOR ASSY			6
1	B	2153350	HEATER			5
1	B	2153348	PLATE, SUPPORT ASSY			4
1	B	2153345	COVER, ASSEMBLY			3
1	B	2153344	BLOWER, MODIFIED			2
1	B	2153564	PLATE, BLOWER BASE			1

LIST OF MATERIAL

NEXT ASSY	FINAL ASSY
APPLICATION	
CONTRACT NUMBER	

UNLESS OTHERWISE SPECIFIED
- INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-70327
- DIMENSIONS ARE IN INCHES
- DIMENSIONS TO BE MET AFTER PLATING
- MACHINED SURFACES TO BE SQUARE & PARALLEL TO DATUM A WITHIN .005 PER IN.
- MACHINED DIAMETERS TO BE CONCENTRIC WITH DATUM A WITHIN .005 T I R

TOLERANCES
DECIMAL
.X ± .040
.XX ± .020
.XXX ± .010
ANGLES ± 0°-30' EXCEPT SPECIFIED CHAMFER ± 10°
SURFACE FINISH MICROINCHES R H R

DRAWN	AL. CAIN	8-13-63
CHECKED		
GROUP LEADER		
ELEC ENGR		
MECH ENGR		
PROJ ENGR	P.A. Michaels	8-16-63
	P.A. Michaels APPROVED	
	W.D. Nuffer 8-27-63 APPROVED	

THE Bendix CORPORATION
RESEARCH LABORATORIES DIVISION
SOUTHFIELD, MICHIGAN

TITLE
AREA H_2 SENSOR ASSEMBLY

CODE IDENT NO.	SIZE		
11272	D	2153341	X3
SCALE 5/1	WT		SHEET

2153341 X3